

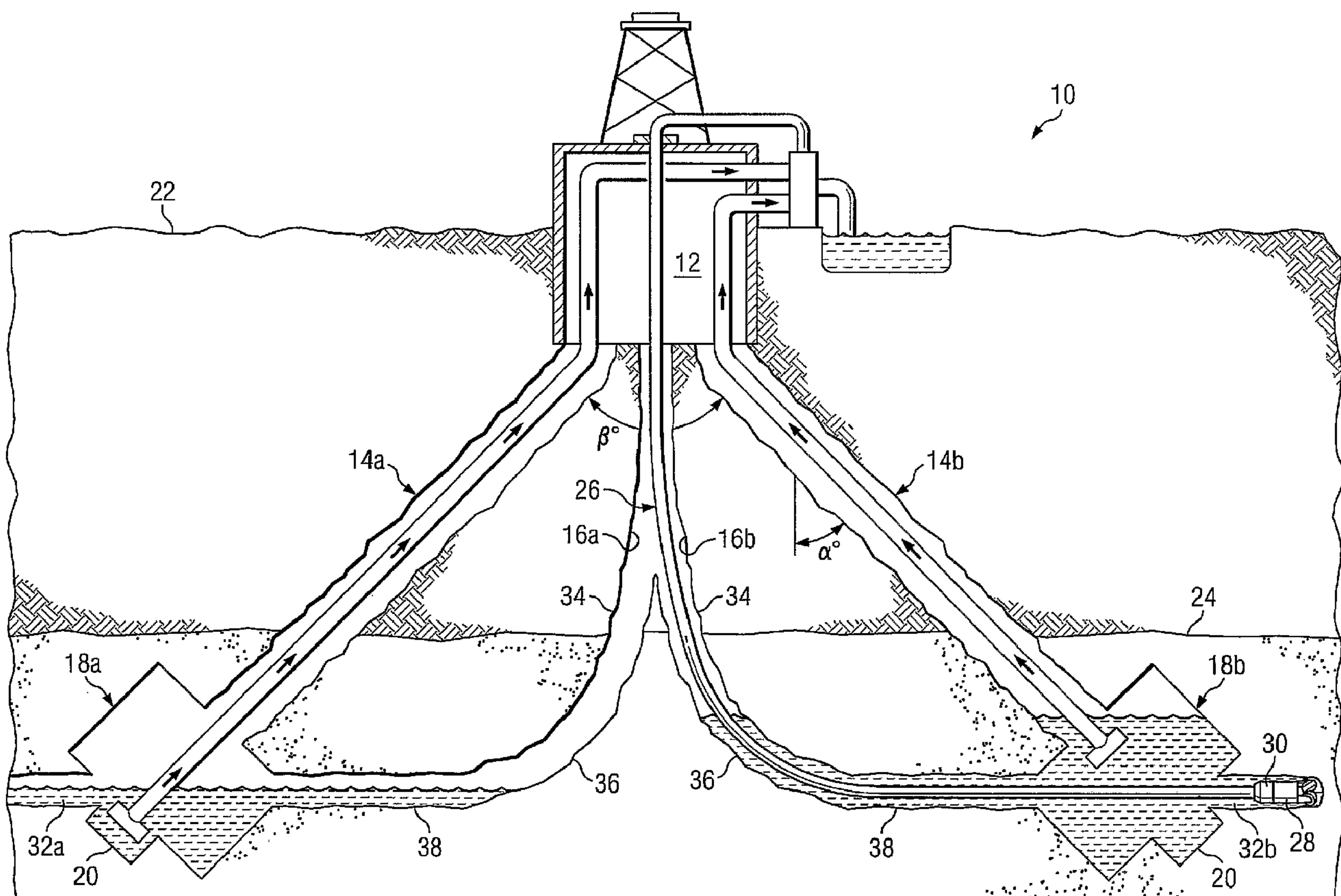


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(54) Title: SYSTEM AND METHOD FOR MULTIPLE WELLS FROM A COMMON SURFACE LOCATION



(57) Abrégé/Abstract:

A system for accessing a subterranean zone (24) from an entry well (12) including an entry well (12) extending from the surface (22). The entry well (12) has a substantially vertical portion. One or more drainage wells (14) extend from the entry well (12) to a subterranean zone (24). One or more articulated wells (16) extend from the entry well (12) to the subterranean zone (24). At least



(57) **Abrégé(suite)/Abstract(continued):**

one of the articulated wells (16) intersects at least one of the one or more drainage wells (14) at a junction proximate the subterranean zone (24). A drainage pattern (32) is formed coupled to the junction and operable to conduct fluids from the subterranean zone (24) to the junction.

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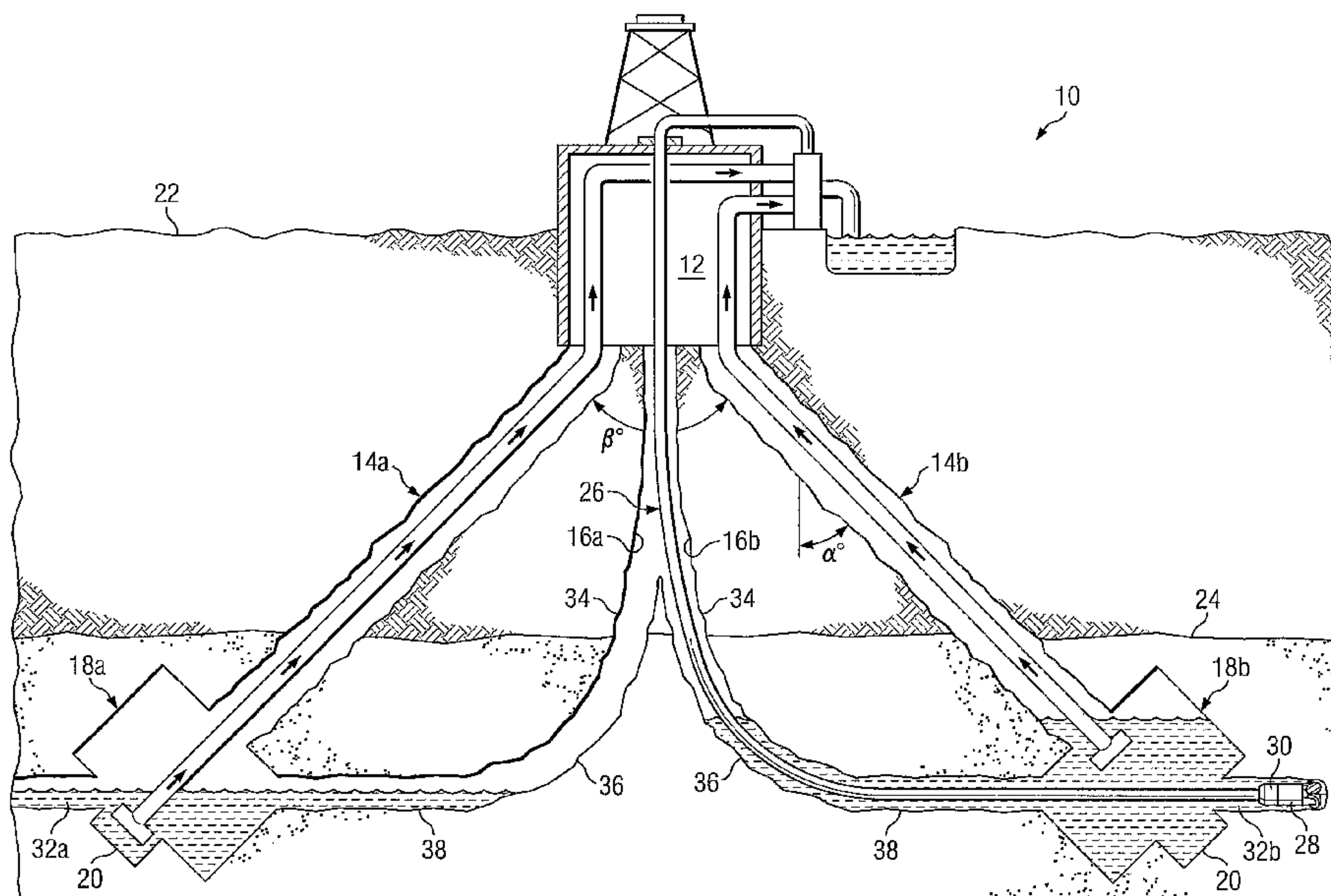
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(54) Title: SYSTEM AND METHOD FOR MULTIPLE WELLS FROM A COMMON SURFACE LOCATION



(57) Abstract: A system for accessing a subterranean zone (24) from an entry well (12) including an entry well (12) extending from the surface (22). The entry well (12) has a substantially vertical portion. One or more drainage wells (14) extend from the entry well (12) to a subterranean zone (24). One or more articulated wells (16) extend from the entry well (12) to the subterranean zone (24). At least one of the articulated wells (16) intersects at least one of the one or more drainage wells (14) at a junction proximate the subterranean zone (24). A drainage pattern (32) is formed coupled to the junction and operable to conduct fluids from the subterranean zone (24) to the junction.

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SYSTEM AND METHOD FOR MULTIPLE WELLS FROM A COMMON SURFACE LOCATION

TECHNICAL FIELD

The present invention relates generally to the field of subterranean exploration
5 and drilling and, more particularly, to a system and method for multiple wells from a
common surface location.

BACKGROUND

Subterranean deposits of coal contain substantial quantities of entrained
methane gas. Limited production in use of methane gas from coal deposits has
10 occurred for many years. Substantial obstacles, however, have frustrated more
extensive development in use of methane gas deposits in coal seams. The foremost
problem in producing methane gas from coal seams is that while coal seams may
extend over large areas of up to several thousand acres, the coal seams are fairly
shallow in depth, varying from a few inches to several meters. Thus, while the coal
15 seams are often relatively near the surface, vertical wells drilling into the coal deposits
for obtaining methane gas can only drain a fairly small radius around the coal
deposits. Further, coal deposits are not amenable to pressure fracturing and other
methods often used for increasing methane gas production from rock formations. As
a result, once the gas easily drained from a vertical well bore in a coal seam is
20 produced further production is limited in volume. Additionally, coal seams are often
associated with subterranean water, which must be drained from the coal seam in
order to produce the methane.

Horizontal drilling patterns have been tried in order to extend the amount of
coal seams exposed to a drill bore for gas extraction. Such horizontal drilling
25 techniques, however, require the use of a radius well bore which presents
difficulties in removing the entrained water from the coal seams. The most efficient

method for pumping water from a subterranean well, a sucker rod pump, does not work well in horizontal or radiused bores.

SUMMARY

5 The present invention provides a system and method using multiple articulated and drainage wells from a common surface well that substantially eliminates, reduces, or minimizes the disadvantages and problems associated with previous systems and methods. In particular, certain embodiments of the present invention provide a system and method using multiple articulated and drainage wells from a single surface well for efficiently producing and removing entrained methane gas and water from a
10 coal seam without requiring that multiple wells be drilled from the surface.

Certain exemplary embodiments can provide claim a method for accessing a subterranean zone, comprising: forming an entry well from the surface, the entry well having a substantially vertical portion; forming a drainage well extending from the entry well to a subterranean zone, the drainage
15 well comprising at least one slanted portion; forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to
20 conduct fluid from the subterranean zone to the junction; and forming a second drainage well from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion; forming a second articulated well from the entry well to the subterranean zone, the second articulated well
25 intersecting the second drainage well at a second junction proximate the subterranean zone.

Certain exemplary embodiments can provide claim a method for accessing a subterranean zone, comprising: forming an entry well from the surface, the entry well having a substantially vertical portion; forming a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion;

5 forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; forming a second drainage well from the entry well to

10 the subterranean zone, the second drainage well comprising at least one slanted portion; and forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone, wherein the drainage wells are radially spaced approximately equally around the entry well.

15 Certain exemplary embodiments can provide claim a method for accessing a subterranean zone, comprising: forming an entry well from the surface, the entry well having a substantially vertical portion; forming a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion; forming an articulated well extending from the entry well to the subterranean zone, the

20 articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; forming a second drainage well from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion;

25 and forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone, wherein the articulated wells are radially spaced approximately equally around the entry well.

Certain exemplary embodiments can provide claim a method for accessing a

30 subterranean zone, comprising: forming an entry well from the surface, the entry well having a substantially vertical portion; forming a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion; forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction

proximate the subterranean zone; forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; forming a second drainage well from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion;

5 forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone; forming a third drainage well from the entry well to the subterranean zone, the third drainage well comprising at least one slanted portion; forming a third articulated well from the entry well to the subterranean zone, the third articulated well

10 intersecting the third drainage well at a third junction proximate the subterranean zone.

Certain exemplary embodiments can provide a system for accessing a subterranean zone from an entry well, comprising: an entry well extending from the surface, the entry well having a substantially vertical portion; a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one

15 slanted portion; an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; an inlet of a downhole pumping unit residing in the junction; a drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; a second drainage well extending from the

20 entry well to the subterranean zone, the second drainage well comprising at least one slanted portion; and a second articulated well intersecting the drainage well at a second junction proximate the subterranean zone.

Certain exemplary embodiments can provide a system for accessing a subterranean zone from an entry well, comprising: an entry well extending from the

25 surface, the entry well having a substantially vertical portion; a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion; an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; an inlet of a downhole pumping unit residing

30 in the junction; and a drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; a second drainage well extending from

the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion; and a second articulated well intersecting the drainage well at a second junction proximate the subterranean zone, wherein the drainage wells are radially spaced approximately equally around the entry well.

5 Certain exemplary embodiments can provide a system for accessing a subterranean zone from an entry well, comprising: an entry well extending from the surface, the entry well having a substantially vertical portion; a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion; an articulated well extending from the entry well to the subterranean
10 zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; an inlet of a downhole pumping unit residing in the junction; and a drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; a second drainage well extending from the entry well to the subterranean zone, the second drainage well comprising at least one
15 slanted portion; and a second articulated well intersecting the drainage well at a second junction proximate the subterranean zone, wherein the articulated wells are radially spaced approximately equally around the entry well.

 Certain exemplary embodiments can provide a system for accessing a subterranean zone from an entry well, comprising: an entry well extending from the
20 surface, the entry well having a substantially vertical portion; a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion; an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; an inlet of a downhole pumping unit residing
25 in the junction; and a drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; a second drainage well extending from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion; a second articulated well intersecting the drainage well at a second junction proximate the subterranean zone; a third drainage well from the entry well to the
30 subterranean zone, the third drainage well comprising at least one slanted portion; a third articulated well from the entry well to the subterranean zone, the third articulated well intersecting the third drainage well at a third junction proximate the subterranean zone.

Certain exemplary embodiments can provide a method for accessing a subterranean zone from an entry well, comprising: forming an entry well from the surface, the entry well having a substantially vertical portion; forming a drainage well
 5 extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion; forming an enlarged cavity in the drainage well proximate the subterranean zone; forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the enlarged cavity of the drainage well at a junction proximate the subterranean zone;
 10 forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction, the drainage pattern extending from the junction into the target zone and comprises a set of lateral wells extending from a main well bore; forming a second drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one
 15 slanted portion; and forming a second articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the enlarged cavity of the drainage well at a junction proximate the subterranean zone.

Certain exemplary embodiments can provide a method for accessing a subterranean zone, comprising: forming an entry well from the surface; forming a
 20 drainage well extending from the entry well to a subterranean zone; forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; forming a drainage bore through the articulated well, the drainage bore coupled to the junction and operable to conduct fluid from the subterranean zone to
 25 the junction; forming a second drainage well from the entry well to the subterranean zone; and forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone.

Certain exemplary embodiments can provide a method for accessing a
 30 subterranean zone, comprising: forming an entry well from the surface; forming a drainage well extending from the entry well to a subterranean zone; forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone; forming a drainage bore through the articulated well, the drainage

bore coupled to the junction and operable to conduct fluid from the subterranean zone to the junction; forming a second drainage well from the entry well to the subterranean zone; and forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction
 5 proximate the subterranean zone, wherein the drainage wells are radially spaced approximately equally around the entry well.

Other embodiments provide a system for accessing a subterranean zone from an entry well including an entry well extending from the surface. The entry well has a substantially vertical portion. One or more drainage wells extend from the entry well to a subterranean zone. One or more
 15 articulated wells extend from the entry well to the subterranean zone. At least one of the articulated wells intersects at least one of the one or more drainage wells at a junction proximate the subterranean zone. A drainage pattern is formed coupled to the junction and operable to conduct fluids from the subterranean zone to the junction.

The technical advantage of the present invention include providing a method
 20 and system for using multiple articulated and drainage wells from a common surface well. In particular, a technical advantage may include the formation of an entry well, a plurality of drainage wells, a plurality of articulated wells, and drainage patterns from a single surface location to minimize the number of surface wells needed to access a subterranean zone for draining of gas and liquid resources. This allows for
 25 more efficient drilling and production and greatly reduces costs and problems associated with other systems and methods.

Other technical advantages of the present invention will be readily apparent to one skilled in the art from the following figures, description, and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

30 For a more complete understanding of the present invention and its advantages, reference is now made to the following description taken in conjunction

with the accompanying drawings, wherein like numerals represent like parts, in which:

FIGURE 1 is a cross-sectional diagram illustrating a system for accessing a subterranean zone through multiple wells drilled from a common surface well;

5 FIGURE 2 is a cross-sectional diagram illustrating production of fluids from a subterranean zone through a well bore system in accordance with one embodiment of the present invention;

FIGURE 3 illustrates one embodiment of subterranean drainage patterns of the well system of FIGURE 2;

10 FIGURE 4 illustrates an example method for producing fluids from a subterranean zone using the well bore system of FIGURE 1;

FIGURE 5A illustrates construction of an example guide tube bundle for insertion into entry well of FIGURE 1; and

15 FIGURE 5B illustrates an example entry well with an installed guide tube bundle.

DETAILED DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a diagram illustrating a system 10 for accessing a subterranean zone using multiple articulated and drainage wells from a common surface well in accordance with an embodiment of the present invention. In particular embodiments, 20 the subterranean zone is a coal seam. However, it should be understood that other subterranean zones can be similarly accessed using system 10 of the present invention to remove and/or produce water, hydrocarbons and other fluids from the zone, to treat minerals in the zone prior to mining operations, or to inject, introduce, or store a fluid or other substance into the zone.

25 Referring to FIGURE 1, system 10 includes an entry well 12, drainage wells 14, articulated wells 16, cavities 18, and sumps 20. Entry well 12 extends from surface 22 towards subterranean zone 24. Drainage wells 14 extend from the terminus of entry well 12 to subterranean zone 24, although drainage wells 14 may alternatively extend from any other suitable portion of entry well 12. Articulated 30 wells 16 also may extend from the terminus of entry well 12 to subterranean zone 24 and may each intersect a corresponding drainage well 14. Cavity 18 and sump 20

may be located at the intersection of an articulated well 16 and a corresponding drainage well 14.

Entry well 12 is illustrated as being substantially vertical; however, it should be understood that entry well 12 may be formed at any suitable angle relative to surface 22 to accommodate, for example, surface geometries and attitudes and/or the geometric configuration or attitude of a subterranean resource. In the illustrated embodiment, drainage wells 14 are formed as slant wells that angle away from entry well 12 at an angle designated α . The angle α depends, in part, on the depth of subterranean zone 24. It will be understood that drainage wells 14 may be formed at other angles to accommodate surface topologies and other factors similar to those affecting entry well 12. Furthermore, although drainage wells 14 are illustrated as having the same angle of slant over their entire length (below entry well 12), drainage wells 14 may have two or more portions below entry well 12 that are at different angles. For example, the portion of drainage wells 14 from which cavity 18 is formed and/or which is intersected by the corresponding articulated well 16 may be substantially vertical. In the illustrated embodiment, drainage wells 14 are formed in relation to each other at an angular separation of β degrees. In one embodiment, the angle β equals twice the angle α . It will be understood that drainage wells 14 may be separated by other angles depending likewise on the topology and geography of the area and location of subterranean zone 24.

In particular embodiments, an enlarged cavity 18 may be formed from each drainage well 14 at the level of subterranean zone 24. As described in more detail below, cavity 18 provides a junction for the intersection of drainage well 14 by a corresponding articulated well 16 used to form a subterranean drainage bore pattern in subterranean zone 24. Cavity 18 also provides a collection point for fluids drained from subterranean zone 24 during production operations. In one embodiment, cavity 18 has a radius of approximately eight feet; however, any appropriate diameter cavity may be used. Cavity 18 may be formed using suitable under-reaming techniques and equipment. A portion of drainage well 14 may continue below cavity 18 to form a sump 20 for cavity 18. Although cavities 18 and sumps 20 are illustrated, it should be understood that particular embodiments do not include a cavity and/or a sump.

Each articulated well 16 extends from the terminus of entry well 12 to cavity 18 of a corresponding drainage well 14 (or to the drainage well 14 if no cavity is formed). Each articulated well 16 includes a first portion 34, a second portion 38, and a curved or radiused portion 36 interconnecting portions 34 and 38. In FIGURE 1, portion 34 is illustrated substantially vertical; however, it should be understood that portion 34 may be formed at any suitable angle relative to surface 22 to accommodate surface 22 geometric characteristics and attitudes and/or the geometric configuration or attitude of subterranean zone 24. Portion 38 lies substantially in the plane of subterranean zone 24 and intersects the large diameter cavity 18 of a corresponding drainage well 14. In FIGURE 1, the plane of subterranean zone 24 is illustrated substantially horizontal, thereby resulting in a substantially horizontal portion 38; however, it should be understood that portion 38 may be formed at any suitable angle relative to surface 22 to accommodate the geometric characteristics of subterranean zone 24. Each articulated well 16 may be drilled using an articulated drill string 26 that includes a suitable down-hole motor and a drill bit 28. A measurement while drilling (MWD) device 30 may be included in articulated drill string 26 for controlling the orientation and direction of a well bore drilled by the motor and bit 28. Any suitable portion of articulated well 16 may be lined with a suitable casing.

In the illustrated embodiment, drainage well 14 is sufficiently angled away from a corresponding articulated well 16 to permit the large radiused curved portion 36 and any desired portion 38 to be drilled before intersecting cavity 18. In particular embodiments, curved portion 36 may have a radius of one hundred to one hundred fifty feet; however, any suitable radius may be used. This angle α may be chosen to minimize the angle of curved portion 36 to reduce friction in articulated well 16 during drilling operations. As a result, the length of articulated well 16 is maximized.

After cavity 18 has been successfully intersected by articulated well 16, drilling is continued through cavity 18 using articulated well string 26 to provide a drainage bore pattern 32 in subterranean zone 24. In FIGURE 1, drainage bore pattern 32 is illustrated substantially horizontal corresponding to a substantially horizontally illustrated subterranean zone 24; however, it should be understood that drainage bore pattern 32 may be formed at any suitable angle corresponding to the geometric characteristics of subterranean zone 24. During this operation, gamma ray

logging tools and conventional MWD devices may be employed to control and direct the orientation of drill bit 28 to retain drainage bore pattern 32 within the confines of subterranean zone 24 and to provide substantially uniform coverage of a desired area within subterranean zone 24. Drainage bore pattern 32 may comprise a single
5 drainage bore extending into subterranean zone 24 or it may comprise a plurality of drainage bores. Further information regarding an example drainage bore pattern 32 is described in more detail below. In addition, although pattern 32 is illustrated as extending from cavity 18, portion 38 of articulated wells 16 may be extended appropriately so that portion 38 serves the function of draining fluids from the
10 subterranean zone 24.

During the process of drilling drainage bore pattern 32 in a coal seam or other appropriate formations, drilling fluid or "mud" may be pumped down articulated drill string 26 and circulated out of drill string 26 in the vicinity of a bit 28, where it is used to scour the formation and to remove formation cuttings. The cuttings are then
15 entrained in the drilling fluid which circulates up through the annulus between drill string 26 and the walls of articulated well 16 until it reaches surface 22, where the cuttings are removed from the drilling fluid and the fluid is then recirculated. This conventional drilling operation produces a standard column of drilling fluid having a vertical height equal to the depth of articulated well 16 and produces a hydrostatic
20 pressure on the well bore corresponding to the well bore depth. Because coal seams tend to be porous and fractured, they may be unable to sustain such hydrostatic pressure, even if formation water is also present in subterranean zone 24.

Accordingly, if the full hydrostatic pressure is allowed to act on subterranean zone 24, the result may be loss of drilling fluid in entrained cuttings into the formation. Such a
25 circumstance is referred to as an "over-balanced" drilling operation in which they hydrostatic fluid pressured in the well bore exceeds the ability of the formation to withstand the pressure. Loss of drilling fluids and cuttings into the formation not only is expensive in terms of the lost drilling fluids, which must be made up, but also tends to plug the pores in subterranean zone 24, which are needed to drain the coal seam of
30 gas and water.

To prevent over-balanced drilling conditions during formation of drainage bore pattern 32, air compressors or other suitable pumps may be provided to circulate

compressed air or other suitable fluids down drainage wells 14 and back up through corresponding articulated wells 16. The circulated air or other fluid will mix with the drilling fluid in the annulus around the articulated drill string 26 and create bubbles throughout the column of drilling fluid. This has the effect of lightening the hydrostatic pressure of the drilling fluid and reducing the down-hole pressure significantly that drilling conditions do not become over-balanced. Aeration of the drilling fluid reduces down-hole pressure to approximately 150-200 pounds per square inch (psi). Accordingly, low pressure coal seams and other subterranean zones can be drilled without substantial loss of drilling fluid and contamination of the zone by the drilling fluid. Alternatively, tubing may be inserted into drainage well 14 such that air pumped down through the tubing forces the fluid back through the annulus between the tubing and drainage well 14.

In yet another embodiment, a pumping mechanism 40 may be installed in cavity 18, as illustrated in FIGURE 1, to pump drilling fluid and cuttings to surface 22 through drainage well 14. This eliminates the friction of air and fluid returning through articulated well 16 and may reduce down-hole pressure to nearly zero.

Foam, which may be compressed air mixed with water, may also be circulated down through the articulated drill string 26 along with the drilling mud in order to aerate the drilling fluid in the annulus as articulated well 16 is being drilled and, if desired, as drainage bore pattern 32 is being drilled. Drilling of drainage bore pattern 32 with the use of an air hammer bit or an air-powered down-hole motor will also supply compressed air or foam to the drilling fluid. In this case, the compressed air or foam which is used to power the down-hole motor and bit 28 exits articulated drill string 26 in the vicinity of drill bit 28. However, the larger volume of air which can be circulated down drainage wells 14 permits greater aeration of the drilling fluid than generally is possible by air supplied through articulated drill string 26.

FIGURE 2 illustrates production of fluids from drainage bore pattern 32a and 32b in subterranean zone 24 in accordance with one embodiment of the present invention. In this embodiment, after wells 14 and 16, respectively, as well as desired drainage bore patterns 32, have been drilled, articulated drill string 26 is removed from articulated wells 16. In particular embodiments, articulate wells may be suitably plugged to prevent gas from flowing through articulate wells 16 to the surface 22.

Referring to FIGURE 2, the inlets for down-hole pumps 40 or other suitable pumping mechanisms are disposed in drainage wells 14 in their respective cavities 18. Each cavity 18 provides a reservoir for accumulated fluids allowing intermittent pumping without adverse effects of a hydrostatic head caused by accumulated fluids in the well bore. Each cavity 18 also provides a chamber for gas/water separation for fluids accumulated from drainage bore patterns 32.

Each down-hole pump 40 is connected to surface 22 via a respective tubing string 42 and may be powered by sucker rods extending down through wells 14 of tubing strings 42. Sucker rods are reciprocated by a suitable surface mounted apparatus, such as a powered walking beam 46 to operate each down-hole pump 40. Each down-hole pump 40 is used to remove water and entrained coal finds from subterranean zone 24 via drainage bore patterns 32. In the case of a coal seam, once the water is removed to the surface, it may be treated for separation of methane which may be dissolved in the water and for removal of entrained finds. After sufficient water has been removed from subterranean zone 24, pure coal seam gas may be allowed to flow to surface 22 through the annulus of wells 14 around tubing strings 42 and removed via piping attached to a well head apparatus. At surface 22, the methane is treated, compressed and pumped through a pipeline for use as fuel in a conventional manner. Each down-hole pump 40 may be operated continuously or as needed to remove water drained from subterranean zone 24 into cavities 18.

FIGURE 3 illustrates one embodiment of the subterranean patterns 32a and 32b for accessing subterranean zone 24 or other subterranean zone. The patterns 32a and 32b may be used to remove or inject water, gas or other fluids. The subterranean patterns 32a and 32b each comprise a multi-lateral pattern that has a main bore with generally symmetrically arranged and appropriately spaced laterals extending from each side of the main bore. As used herein, the term each means every one of at least a subset of the identified items. It will be understood that other suitable multi-branching or other patterns including or connected to a surface production bore may be used. For example, the patterns 32a and 32b may each comprise a single main bore. Referring to FIGURE 3, patterns 32a and 32b each include a main bore 150 extending from a corresponding cavity 18a or 18b, respectively, or intersecting wells 14 or 16 along a center of a coverage area to a distal end of the coverage area. The

main bore 150 includes one or more primary lateral bores 152 extending from the main bore 150 to at least approximately to the periphery of the coverage area. The primary lateral bores 152 may extend from opposite sides of the main bore 150. The primary lateral bores 152 may mirror each other on opposite sides of the main bore 150 or may be offset from each other along the main bore 150. Each of the primary lateral bores 152 may include a radiused curving portion extending from the main bore 150 and a straight portion formed after the curved portion has reached a desired orientation. For uniform coverage, the primary lateral bores 152 may be substantially evenly spaced on each side of the main bore 150 and extend from the main bore 150 at an angle of approximately forty-five degrees. The primary lateral bores 152 may be shortened in length based on progression away from the corresponding cavity 18a or 18b. Accordingly, the distance between the cavity or intersecting well bore and the distal end of each primary lateral bore 152 through the pattern may be substantially equally for each primary lateral 152.

One or more secondary lateral bores 152 may be formed off one or more of the primary lateral bores 152. In a particular embodiment, a set of secondary laterals 154 may be formed off the primary lateral bores 152 of each pattern 32a and 32b closest to the corresponding cavity 18a and 18b. The secondary laterals 154 may provide coverage in the area between the primary lateral bores 152 of patterns 32a and 32b. In a particular embodiment, a first primary lateral 154 may include a reversed radius section to provide more uniform coverage of subterranean zone 24.

The subterranean patterns 32a and 32b with their central bore and generally symmetrically arranged and appropriately spaced auxiliary bores on each side may provide a substantial uniform pattern for draining fluids from subterranean zone 24 or other subterranean zone. The number and spacing of the lateral bores may be adjusted depending on the absolute, relative and/or effective permeability of the coal seam and the size of the area covered by the pattern. The area covered by the pattern may be the area drained by the pattern, the area of a spacing unit that the pattern is designed to drain, the area within the distal points or periphery of the pattern and/or the area within the periphery of the pattern as well as surrounding area out to a periphery intermediate to adjacent or neighboring patterns. The coverage area may also include the depth, or thickness of the coal seam or, for thick coal seams, a portion

of the thickness of the seam. Thus, the pattern may include upward or downward extending branches in addition to horizontal branches. The coverage area may be a square, other quadrilateral, or other polygon, circular, oval or other ellipsoid or grid area and may be nested with other patterns of the same or similar type. It will be
5 understood that other suitable drainage bore patterns may be used.

As previously described, the well bore 150 and the lateral bores 152 and 154 of patterns 32a and 32b are formed by drilling through the corresponding cavity 18a or 18b using the drill string 26 in appropriate drilling apparatus. During this operation, gamma ray logging tools and conventional MWD technologies may be
10 employed to control the direction and orientation of drill bit 28 so as to retain the drainage bore pattern within the confines of subterranean zone 24 and to maintain proper spacing and orientation of wells 150 and 152. In a particular embodiment, the main well bore 150 of each pattern 32a and 32b is drilled with an incline at each of the plurality of lateral branch points 156. After the main well bore 150 is complete,
15 the drill string 26 is backed up to each successive lateral point 156 from which a primary lateral bore 152 is drilled on each side of the well bore 150. The secondary laterals 154 may be similarly formed. It will be understood that the subterranean patterns 32a and 32b may be otherwise suitably formed. Furthermore, as described above, a pattern (as illustrated in FIGURE 3) or otherwise may be formed off of
20 portion 38 of articulated well 16 (which would function as well bore 150) such that cavities 18 are located at the end of portion 38/well bore 150.

FIGURE 4 is a flow diagram illustrating a method for preparing subterranean zone 24 for mining operations in accordance with particular embodiments of the present invention. The example method begins at step 400 in which entry well 12 is
25 drilled substantially vertically from the surface. At step 402, a casing with guide tubes is installed into the entry well 12. At step 404, the casing is cemented in place inside entry well 12.

At step 406, drill string 26 is inserted through entry well 12 and one of the guide tubes in the guide tube bundle. At step 408, drill string 26 is used to drill
30 approximately fifty feet past the casing. At step 410, the drill is oriented to the desired angle of the drainage well 14 and, at step 412, drainage well bore 14 is drilled down into and through target subterranean zone 24.

At step 414, down-hole logging equipment may be utilized to identify the location of the subterranean zone 24. At step 416, cavity 18a is formed in first drainage well 14 at the location of subterranean zone 24. As previously discussed, cavity 18 may be formed by underreaming and other conventional techniques. At
 5 decisional step 418, if additional drainage wells are to be drilled, the method returns to step 406. If no additional drainage wells 14 are to be drilled, then the method proceeds to step 420.

At step 420, articulated well 16 is drilled to intersect cavity 18. At steps 422 and 424, drainage bore pattern 32 is drilled into subterranean zone 24. At step 426, production
 10 equipment is installed into drainage wells 14 and at step 428 the process ends with the production of fluids (such as water and gas) from the subterranean zone 24.

Although the steps have been described in a certain order, it will be understood that they may be performed in any other appropriate order. Furthermore, one or more steps may be omitted, or additional steps performed, as appropriate.

15 FIGURE 5A illustrates formation of a casing with associated guide tube bundle as described in step 402 of FIGURE 4. Three guide tubes 48 are shown in side view and end view. The guide tubes 48 are arranged so that they are parallel to one another. In the illustrated embodiment, guide tubes 48 are 9 5/8" joint casings. It will be understood that other suitable materials may be employed. As an example, guide
 20 tubes 48a and 48b serve as the tubes through which drainage wells 14a and 14b are drilled, respectively. In this example, guide tube 48c serves as the tube through which both articulated wells 16a and 16b are drilled. It will be understood that other suitable arrangements may be employed. In another embodiment, guide tubes 48 may be attached to a casing collar such that the guide tubes 48 and casing collar make up the
 25 guide tube bundle.

FIGURE 5B illustrates entry well 12 with guide tubes 48 and a casing collar 50 cemented in entry well 12. Entry well 12 is formed from the surface 22 to a target depth (in particular embodiments, approximately three hundred feet). In a particular embodiment, entry well 12 has a diameter of approximately twenty-four inches.
 30 Forming entry well 12 corresponds with step 400 of FIGURE 4. Guide tubes 48 are shown attached to a casing collar 50. Casing collar 50 may be any casing suitable for

use in down-hole operations. Inserting casing collar 50 and guide tubes 48 into entry well 12 corresponds with step 402 of FIGURE 4.

Corresponding with step 404 of FIGURE 4, a cement retainer 52 is poured or otherwise installed around the casing inside entry well 12. The cement casing may be
5 any mixture or substance otherwise suitable to maintain casing 50 in the desired position with respect to entry well 12.

In operation, drill string 26 is positioned to enter one of the guide tubes 48. In order to keep drill string 26 relatively centered in casing 50, a stabilizer 54 may be employed. Stabilizer 54 may be a ring and fin type stabilizer or any other stabilizer
10 suitable to keep drill string 26 relatively centered. To keep stabilizer 54 at a desired depth in well bore 12, stop ring 56 may be employed. Stop ring 56 may be constructed of rubber or metal or any other foreign down-hole environment material suitable. Drill string 26 may be inserted randomly into any of a plurality of guide tubes 48, or drill string 26 may be directed into a selected guide tube 48a. This
15 corresponds to step 406 of FIGURE 4.

What is claimed is:

1. A method for accessing a subterranean zone, comprising:
 forming an entry well from the surface, the entry well having a substantially
 5 vertical portion;
 forming a drainage well extending from the entry well to a subterranean zone, the
 drainage well comprising at least one slanted portion;
 forming an articulated well extending from the entry well to the subterranean
 zone, the articulated well extending from the entry well to intersect the drainage well at a
 10 junction proximate the subterranean zone;
 forming a drainage pattern through the articulated well, the drainage pattern
 coupled to the junction and operable to conduct fluid from the subterranean zone to the
 junction; and
 forming a second drainage well from the entry well to the subterranean zone, the
 15 second drainage well comprising at least one slanted portion;
 forming a second articulated well from the entry well to the subterranean zone,
 the second articulated well intersecting the second drainage well at a second junction
 proximate the subterranean zone.
- 20 2. The method of claim 1, further comprising forming an enlarged cavity in the
 drainage well proximate the subterranean zone.
3. The method of claim 1, further comprising inserting a guide tube bundle into the
 entry well and forming one or more of the drainage well or the articulated well using the
 25 guide tube bundle.
4. The method of claim 1, wherein forming the drainage pattern comprises forming
 a main well bore and a plurality of lateral well bores extending from the main well bore.
- 30 5. The method of claim 4, wherein the lateral wells are configured to drain an area
 of the subterranean zone of at least 640 acres.

6. The method of claim 1, further comprising removing resources from the subterranean zone through the drainage pattern to the surface.

7. A method for accessing a subterranean zone, comprising:

5 forming an entry well from the surface, the entry well having a substantially vertical portion;

forming a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion;

10 forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone;

forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction;

15 forming a second drainage well from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion; and

forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone,

20 wherein the drainage wells are radially spaced approximately equally around the entry well.

8. A method for accessing a subterranean zone, comprising:

25 forming an entry well from the surface, the entry well having a substantially vertical portion;

forming a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion;

30 forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone;

forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction;

forming a second drainage well from the entry well to the subterranean zone, the
5 second drainage well comprising at least one slanted portion; and

forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone,

wherein the articulated wells are radially spaced approximately equally around
10 the entry well.

9. A method for accessing a subterranean zone, comprising:

forming an entry well from the surface, the entry well having a substantially vertical portion;

15 forming a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion;

forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone;

20 forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction;

forming a second drainage well from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion;

25 forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone;

forming a third drainage well from the entry well to the subterranean zone, the third drainage well comprising at least one slanted portion;

30 forming a third articulated well from the entry well to the subterranean zone, the third articulated well intersecting the third drainage well at a third junction proximate the subterranean zone.

10. A system for accessing a subterranean zone from an entry well, comprising:
 an entry well extending from the surface, the entry well having a substantially
 vertical portion;

5 a drainage well extending from the entry well to a subterranean zone, the
 drainage well comprising at least one slanted portion;

an articulated well extending from the entry well to the subterranean zone, the
 articulated well extending from the entry well to intersect the drainage well at a junction
 proximate the subterranean zone;

10 an inlet of a downhole pumping unit residing in the junction;

a drainage pattern coupled to the junction and operable to conduct fluid from the
 subterranean zone to the junction;

a second drainage well extending from the entry well to the subterranean zone,
 the second drainage well comprising at least one slanted portion; and

15 a second articulated well intersecting the drainage well at a second junction
 proximate the subterranean zone.

11. The system of claim 10, further comprising an enlarged cavity formed in the
 drainage well proximate the subterranean zone.

20

12. The system of claim 10, further comprising a guide tube bundle inserted into the
 entry well for forming one or more of the drainage well or the articulated well.

13. The system of claim 10, wherein the drainage pattern comprises a main well bore
 25 and a plurality of lateral well bores extending from the main well bore.

14. The system of claim 13, wherein the lateral wells are configured to drain an area
 of the subterranean zone of at least 640 acres.

30 15. A system for accessing a subterranean zone from an entry well, comprising:
 an entry well extending from the surface, the entry well having a substantially
 vertical portion;

a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion;

an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone;

an inlet of a downhole pumping unit residing in the junction; and

a drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction;

a second drainage well extending from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion; and

a second articulated well intersecting the drainage well at a second junction proximate the subterranean zone,

wherein the drainage wells are radially spaced approximately equally around the entry well.

15

16. A system for accessing a subterranean zone from an entry well, comprising:

an entry well extending from the surface, the entry well having a substantially vertical portion;

a drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion;

an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone;

an inlet of a downhole pumping unit residing in the junction; and

a drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction;

a second drainage well extending from the entry well to the subterranean zone, the second drainage well comprising at least one slanted portion; and

a second articulated well intersecting the drainage well at a second junction proximate the subterranean zone,

wherein the articulated wells are radially spaced approximately equally around the entry well.

17. A system for accessing a subterranean zone from an entry well, comprising:
 an entry well extending from the surface, the entry well having a substantially
 vertical portion;

5 a drainage well extending from the entry well to a subterranean zone, the
 drainage well comprising at least one slanted portion;

an articulated well extending from the entry well to the subterranean zone, the
 articulated well extending from the entry well to intersect the drainage well at a junction
 proximate the subterranean zone;

10 an inlet of a downhole pumping unit residing in the junction; and

a drainage pattern coupled to the junction and operable to conduct fluid from the
 subterranean zone to the junction;

a second drainage well extending from the entry well to the subterranean zone,
 the second drainage well comprising at least one slanted portion;

15 a second articulated well intersecting the drainage well at a second junction
 proximate the subterranean zone;

a third drainage well from the entry well to the subterranean zone, the third
 drainage well comprising at least one slanted portion;

a third articulated well from the entry well to the subterranean zone, the third
 20 articulated well intersecting the third drainage well at a third junction proximate the
 subterranean zone.

18. A method for accessing a subterranean zone from an entry well, comprising:

forming an entry well from the surface, the entry well having a substantially
 25 vertical portion;

forming a drainage well extending from the entry well to a subterranean zone, the
 drainage well comprising at least one slanted portion;

forming an enlarged cavity in the drainage well proximate the subterranean zone;

forming an articulated well extending from the entry well to the subterranean
 30 zone, the articulated well extending from the entry well to intersect the enlarged cavity of
 the drainage well at a junction proximate the subterranean zone;

forming a drainage pattern through the articulated well, the drainage pattern coupled to the junction and operable to conduct fluid from the subterranean zone to the junction, the drainage pattern extending from the junction into the target zone and comprises a set of lateral wells extending from a main well bore;

5 forming a second drainage well extending from the entry well to a subterranean zone, the drainage well comprising at least one slanted portion; and

 forming a second articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the enlarged cavity of the drainage well at a junction proximate the subterranean zone.

10

19. A method for accessing a subterranean zone, comprising:

 forming an entry well from the surface;

 forming a drainage well extending from the entry well to a subterranean zone;

 forming an articulated well extending from the entry well to the subterranean

15 zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone;

 forming a drainage bore through the articulated well, the drainage bore coupled to the junction and operable to conduct fluid from the subterranean zone to the junction;

 forming a second drainage well from the entry well to the subterranean zone; and

20 forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone.

20. The method of claim 19, further comprising forming an enlarged cavity in the
25 drainage well proximate the subterranean zone.

21. The method of claim 19, further comprising removing resources from the subterranean zone through the drainage pattern to the surface.

30 22. A method for accessing a subterranean zone, comprising:

 forming an entry well from the surface;

 forming a drainage well extending from the entry well to a subterranean zone;

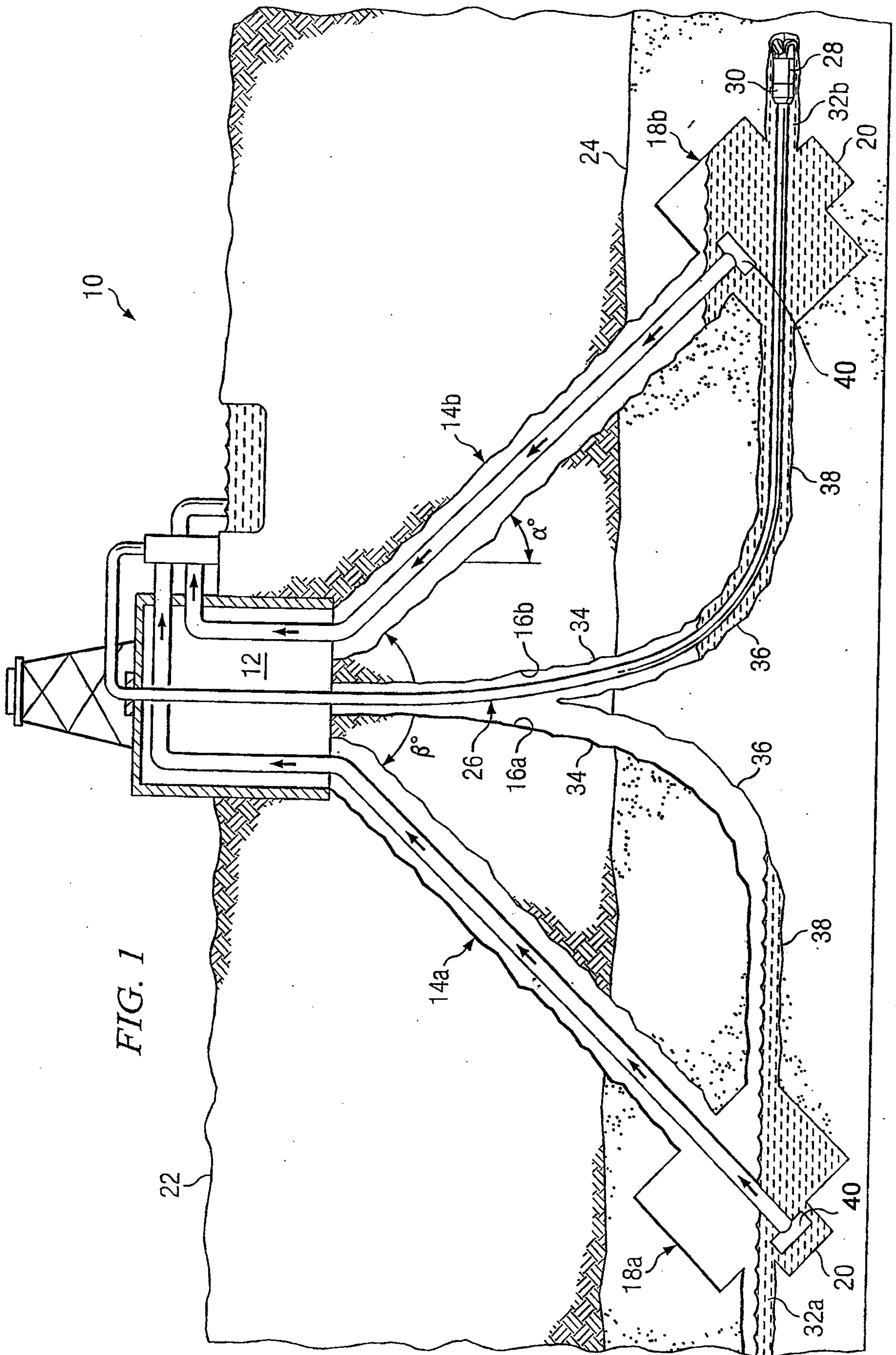
forming an articulated well extending from the entry well to the subterranean zone, the articulated well extending from the entry well to intersect the drainage well at a junction proximate the subterranean zone;

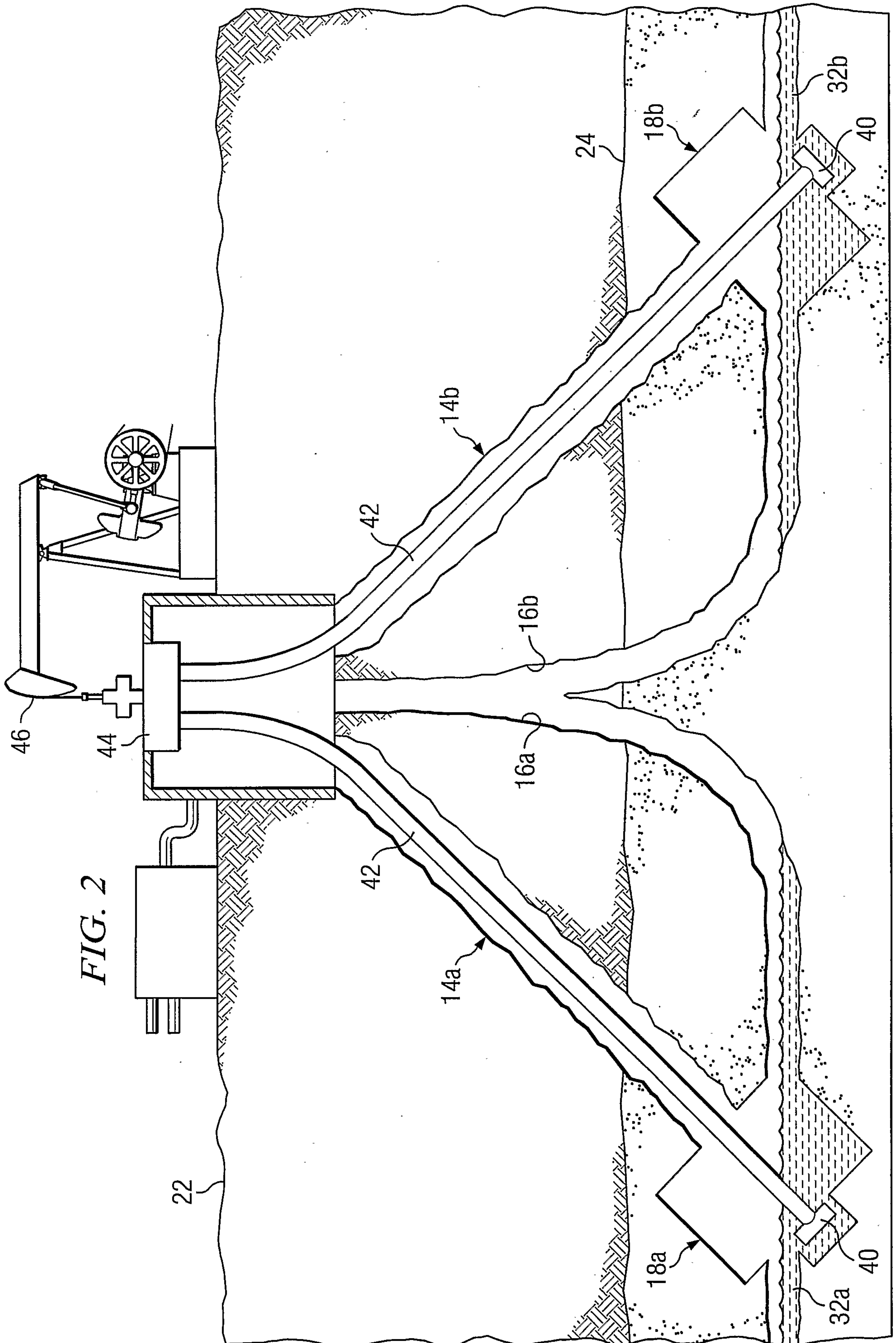
5 forming a drainage bore through the articulated well, the drainage bore coupled to the junction and operable to conduct fluid from the subterranean zone to the junction;

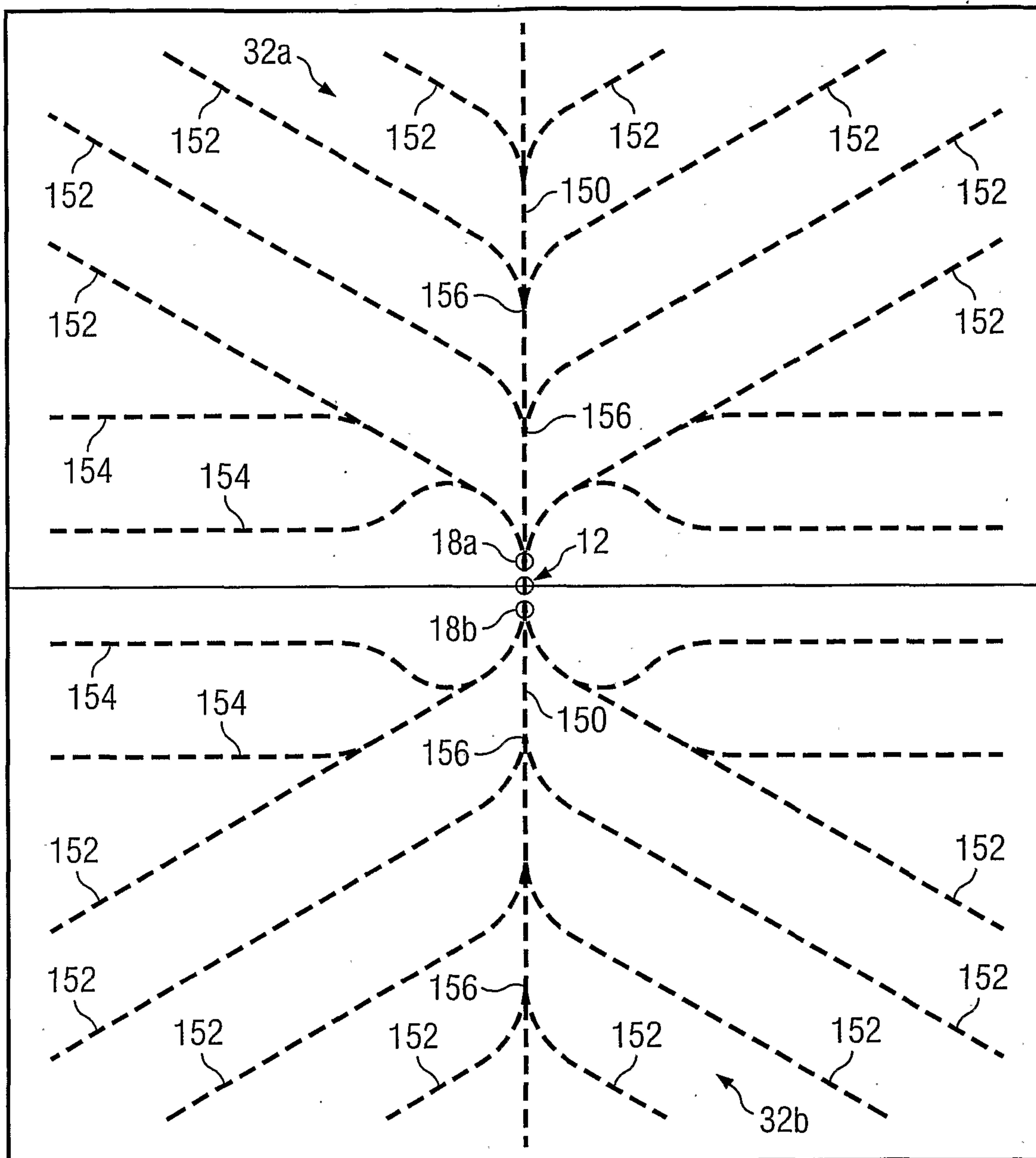
 forming a second drainage well from the entry well to the subterranean zone; and

 forming a second articulated well from the entry well to the subterranean zone, the second articulated well intersecting the second drainage well at a second junction proximate the subterranean zone,

10 wherein the drainage wells are radially spaced approximately equally around the entry well.





*FIG. 3*

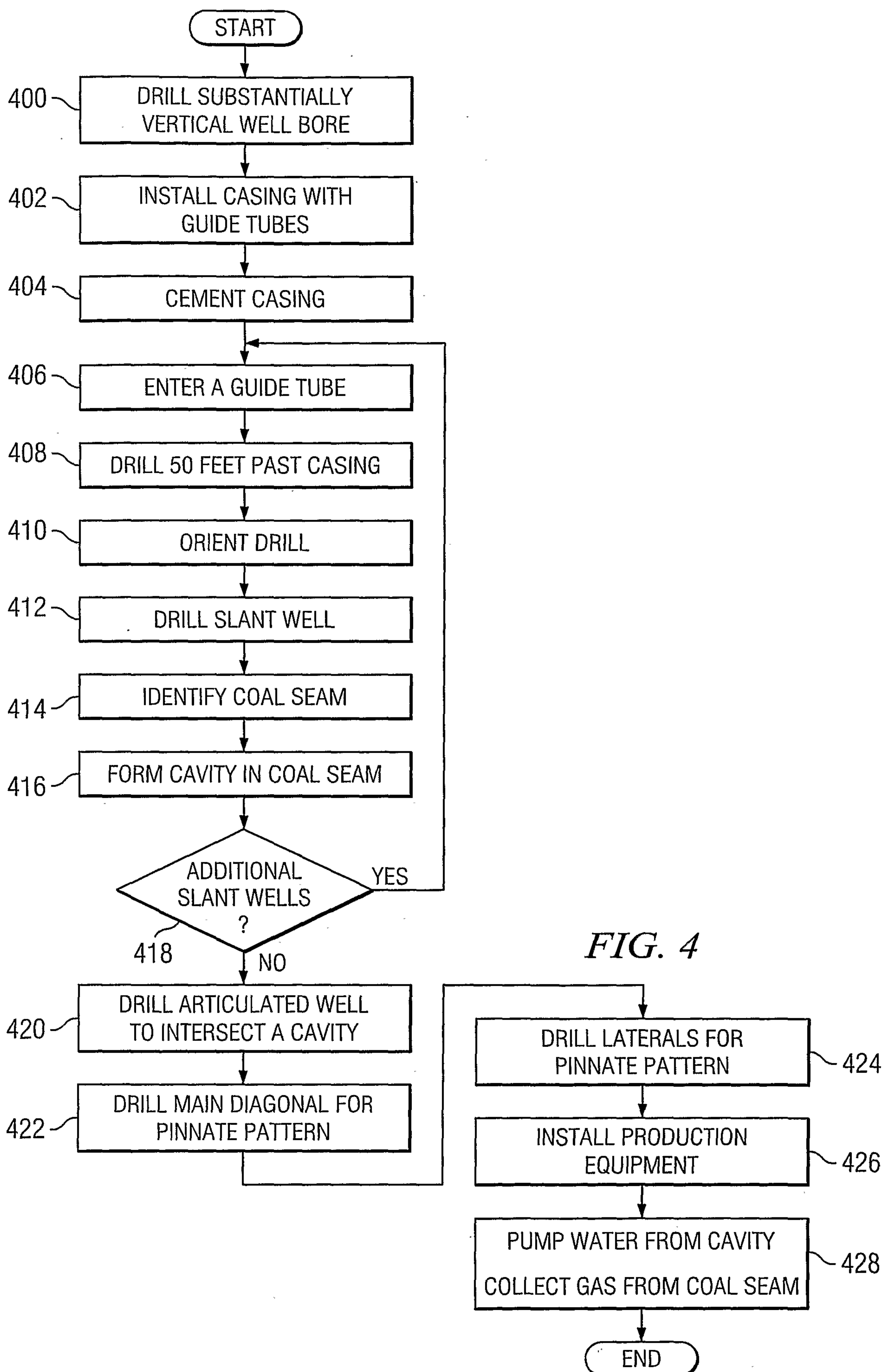
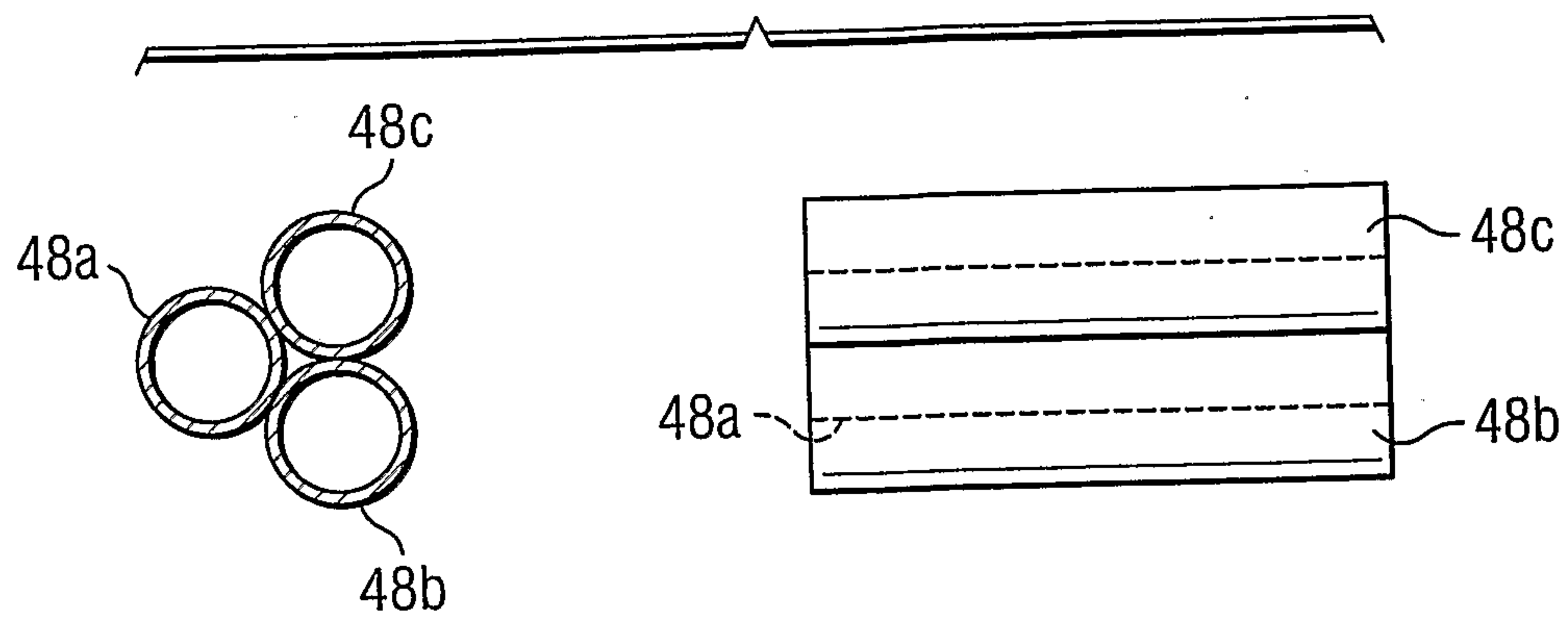


FIG. 5A*FIG. 5B*